GLUTEN SUBSTITUTES

FIELD OF THE INVENTION

The present invention relates generally to the preparation of food products that are typically produced using wheat flour. More particularly, the present invention relates to novel gluten substitutes and methods for their production for use *inter alia* in the preparation of bread, cake and pastry-type products.

BACKGROUND OF THE INVENTION

Bakery products are commonly made from wheat flour containing gluten, which contributes to the typical texture, flavour and form of the usual bread, cake and pastry products. A substantial segment of the population, however, suffers from dietary wheat intolerance such as celiac disease and other less well-defined wheat intolerances and allergies which make wheat based products unacceptable for use. Unfortunately, these people have few alternatives for conventional baked products.

Despite the desirability of developing bakery products that are not based on wheat flour, this development has been hindered largely by the unavailability of alternative compounds that mimic the critical role that gluten plays in the baking process. Gluten is especially important in this regard because of its unique ability to form the viscoelastic matrix of dough, which transforms it into a firm loaf of bread when baked. However, gluten-free flours typically have very little, if any, binding capacity and consequently, form pastes or slurries instead of dough when mixed with yeast and water.

Current methods for producing gluten-free bread, for example, include mixing gluten-free flour with water, eggs, salt, sugar, yeast, milk and a small amount of binding agent (0.5 to 5.0% by weight), usually xanthan gum, guar gum, or pre-gelatinized starch typically referred to as a gluten substitute. Unfortunately, the resulting breads are very cake-like and heavy whilst their mouth feel and texture are generally unpleasant. As a result, many gluten intolerant individuals avert eating bread products all together.

By further example, dough can be made from gluten-free flour mixed with commercially available gluten. If the gluten is mixed with these flours in the amount of 15

to 20% by weight (i.e., in an amount 3-40 times greater than the above mentioned gluten substitutes) and then combined with water, a strong dough results, capable of being manipulated in much the same way as dough made from naturally-occurring gluten based flours. However, this dough contains gluten and cannot be used for gluten intolerant individuals.

Casual observations of commercially available gluten powder when mixed with water shows some distinct and easily recognizable properties. The mixture quickly becomes a very strong gum that takes considerable effort to stretch or snap. When snapped into separate pieces, it can be re-constituted into a single whole, simply by kneading it back together. If left to dry, it forms a shiny skin whilst remaining moist on the inside.

From the foregoing, it is desirable to produce a gluten substitute, which can be used to prepare gluten-free food products and which ameliorates at least one of the aforesaid disadvantages of the prior art.

SUMMARY OF THE INVENTION

The present inventor has surprisingly discovered that a gluten substitute gum can be produced by heating an aqueous mixture comprising a starch, an edible fat and an edible protein for a time and under conditions sufficient to produce an aerated mass. When mixed with water, this aerated mass largely mimics gluten in that it takes considerable effort to stretch or snap. When snapped into separate pieces, it can be re-constituted into a single whole simply by kneading it back together. It also forms a shiny skin when left to dry whilst remaining moist on the inside. When mixed with flour, whether gluten-free or otherwise, a dough is formed quickly. The dough absorbs water at a similar rate to wheat flour-based dough, strengthens with kneading and can be stretched or rolled to very thin consistency in a similar manner to wheat flour-based doughs. The foregoing discoveries have been reduced to practice in novel gums and methods for their production as well as novel compositions and kits for the preparation of bakery and other food products as described hereinafter.

Accordingly, in one aspect of the present invention, there is provided a method of producing a gluten substitute gum, said method comprising heating a mixture comprising a starch, an edible fat and an edible protein together with a liquid for a time and under

conditions sufficient to form an aerated mass.

In another aspect, the invention contemplates a plurality of ingredients in mix or in kit form for producing a gluten substitute gum, said ingredients comprising a starch, an edible fat and an edible protein which are present in relative amounts sufficient to form an aerated mass upon mixing with a predetermined amount of liquid and heating the mixture so formed at an aerated mass-forming effective temperature.

In yet another aspect, the invention encompasses use of a starch, an edible fat and an edible protein in the preparation of a mix or kit for the production of a gluten substitute gum.

In still yet another aspect, the invention provides a gluten substitute gum produced by mixing together a starch, an edible fat, an edible protein and a liquid and heating the mixture for a time and under conditions sufficient to form an aerated mass.

In a further aspect of the invention, there is provided a mix for the preparation of bakery products, said mix comprising a gluten substitute gum as broadly described above together with a gluten-free starch in relative amounts sufficient to form a coherent dough system upon the addition of a liquid, and to retain leavening gas during the preparation of said dough, wherein said products are producible in the substantial absence of wheat flour.

In another aspect, the invention contemplates use of a gluten substitute gum as broadly described above in the preparation of a mix for producing foodstuffs including bakery products.

According to yet another aspect, the invention provides a method for producing bakery products, said method comprising mixing a gluten substitute gum as broadly described above together with a gluten-free starch and water to form a dough and heating the dough for a time and at a temperature sufficient to produce said bakery products.

In yet another aspect, the invention resides in food products including bakery products produced using the gluten substitute gum as broadly described above.

DETAILED DESCRIPTION OF THE INVENTION

1. Definitions

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by those of ordinary skill in the art to which the invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, preferred methods and materials are described. For the purposes of the present invention, the following terms are defined below.

The articles *"a"* and *"an"* are used herein to refer to one or to more than one (i.e. to at least one) of the grammatical object of the article. By way of example, "an element" means one element or more than one element.

Throughout this specification, unless the context requires otherwise, the words *"comprise"*, *"comprises"* and *"comprising"* will be understood to imply the inclusion of a stated step or element or group of steps or elements but not the exclusion of any other step or element or group of steps or elements.

By *"edible fat"* or *"edible protein"* is meant a fat or protein that is fit or safe for animal consumption including human consumption.

2. Gluten substitute gum

The present invention is predicated in part on the discovery that a gluten substitute gum can be produced by heating a mixture, preferably an aqueous mixture comprising a starch, an edible fat and an edible protein for a time and under conditions sufficient to produce an aerated mass with gluten-like properties. The invention thus provides a method of producing a gluten substitute gum, comprising heating an mixture comprising a starch, an edible fat, an edible protein and a liquid, preferably water, for a time and under conditions sufficient to form an aerated mass.

Preferably, the starch is present in an amount of between about 20 and 80% by weight, more preferably between about 30 and 70% by weight and even more preferably between about 40 and 60% by weight of said mixture.

Suitably, the starch has less than 20 parts per million of gluten. In this connection, the starch preferably conforms to the Codex Alimentarius standard as set by the World Health Organization.

The starch is suitably selected from potato starch, sweet potato starch, white rice starch, glutinous rice starch, maize starch, Codex Alimentarius wheat starch, sorghum starch, cassava starch, arrowroot starch and tapioca starch. Preferably, the starch is selected from the group consisting of tapioca starch, arrowroot starch and maize starch. More preferably, the starch is tapioca starch.

The edible fat suitably comprises any edible fatty substances in a general sense, including, but not restricted to, natural fats or synthesized fats and oils consisting essentially of triglycerides. The fat may be derived from any animal or plant source including, for example, canola oil, corn oil, grapeseed oil, soybean oil, sunflower seed oil, safflower oil, rapeseed oil, cottonseed oil, sesame oil, olive oil, palm oil, coconut oil, fish oil, copha, margarine, butter, milk fat, chicken fat, lard and tallow, which may have been partially or completely hydrogenated or modified otherwise, as well as non-toxic fatty materials having properties similar to triglycerides and any combination thereof. The terms fat and oil are used interchangeably. The edible fat may be solid or fluid at room temperatures of from about 15 °C to about 35 °C.

Preferably, the edible fat is present in an amount of between about 1 and 10% by weight, more preferably between about 1 and 6% by weight and even more preferably between about 1 and 4% by weight of said mixture.

It is preferred that the edible fat to starch ratio in said mixture is less than about 15:100, more preferably less than about 12:100, more preferably less than 10:100.

The edible protein suitably comprises any edible proteinaceous substance synthetic or otherwise that is suitable for human consumption. Typical protein sources from which the edible protein may be derived include, but are not restricted to, animal produce such as meat, poultry, eggs, milk, cheese and the like, and plant produce such as bean flour, rice flour and the like as well as nuts such as peanuts, hazelnuts, walnuts, sunflower seeds, cashews, sesame seeds, pumpkin seeds, almonds, pine nuts, macadamia nuts, any other edible nut and any combination thereof. Exemplary animal proteins

include but are not limited to, gelatin, whey and egg white. Exemplary plant proteins include soybean protein and rice protein.

Preferably, the edible protein is present in an amount of between about 2 and 20% by weight, more preferably between about 2 and 12% by weight and even more preferably between about 2 and 8% by weight of said mixture.

It is preferred that the edible protein to starch ratio in said mixture is less than about 30:100, more preferably less than about 25:100, more preferably less than 20:100.

Preferably, the edible protein to edible fat ratio is about 3:1, more preferably about 2.5:1 and still more preferably about 2:1.

Water is preferably present in said mixture in an amount of between about 20 and 80% by weight, more preferably between about 30 and 70% by weight and even more preferably between about 40 and 60% by weight of said mixture

In a preferred embodiment, the edible fat and the edible protein are obtained from or provided in the form of a foodstuff comprising both the edible fat and the edible protein. For example, the foodstuff may be selected from milk or other dairy products, eggs, vegetables. Preferably, the foodstuff is a gluten-free flour such as, for example, buckwheat flour, sorghum flour, maize flour, white rice flour and soybean flour. More preferably, the foodstuff is soybean flour.

Preferably, the mixture is heated to a temperature of between about 110 and 150 °C, more preferably between about 120 and about 140 °C, more preferably between about 125 and 135 °C and still more preferably between about 130 and 133 °C.

Any mode of heating, which is suitable for the formation of the aerated mass, is contemplated by the present invention. Preferably heating is effected by microwaves. Alternatively, the heating can be carried out by use of a compression means such as an extruder.

Suitably, the mixture is heated for a time sufficient to produce the aerated mass without burning.

Preferably, the method further comprises drying the aerated mass. The drying

may be effected by any suitable means including, but not restricted to, heating the aerated mass to effect evaporation of water therefrom. The heating may be effected using microwaves, extrusion, convection heating, blow drying and desiccating or any other means to effect evaporation of water from the aerated mass.

Suitably, the method further comprises grinding or crushing the dry aerated mass to form a ground or powder.

The gluten free gum can be used for the preparation of foodstuffs including bakery products in the form of a wet gum but is preferably used in the form of a dried ground or powder.

The invention also contemplates a plurality of ingredients in mix or in kit form for producing a gluten substitute gum. The ingredients comprise a starch, an edible fat and an edible protein which are present in relative amounts sufficient to form an aerated mass upon mixing with a predetermined amount of water and heating the mixture so formed at an aerated mass-forming effective temperature.

Preferably, the edible fat is present in an amount between about 0.5 and 5% by weight, more preferably between about 0.5 and 3% by weight and even more preferably between about 0.5 and 2% by weight of the total ingredients in said mix or kit.

The edible fat to starch ratio in said mix or kit is preferably less than about 15:100, more preferably less than about 12:100, more preferably less than 10:100.

Preferably, the edible protein is present in an amount of between about 1 and 10% by weight, more preferably between about 1 and 6% by weight and even more preferably between about 1 and 4% by weight of said the total ingredients in said mix or kit.

The edible protein to starch ratio in said mix or kit is preferably less than about 30:100, more preferably less than about 25:100, more preferably less than 20:100.

Preferably, the edible protein to edible fat ratio in said mix or kit is about 3:1, more preferably about 2.5:1 and still more preferably about 2:1.

The invention also provides a gluten substitute gum produced by mixing together a starch, an edible fat, an edible protein and a liquid and heating the mixture for a time and

under conditions sufficient to form an aerated mass.

The invention also encompasses a mix for the preparation of bakery products. The mix comprises the gluten substitute gum of the invention together with a gluten-free starch in relative amounts sufficient to form a coherent dough system upon the addition of water, and to retain leavening gas during the preparation of said dough. The ratio of starch to gluten-substitute gum will vary depending on the intended purpose of the mix. However, for most bakery products the ratio of starch to gluten-substitute gum is preferably in the range of about 6:1 to 7:1.

It will be appreciated that the gluten-substitute gum of the invention can thus be used to prepare various mixes for cakes, pastries and bread products. These mixes can include other standard ingredients known *per se* in the art and the choice and grade of said other ingredients in a complete mix are not critically related to the invention and may follow standard practice in the art. Thus, the invention contemplates use of any of the usual basic gas producing chemical leavening substances as well as flavorings in the aforesaid mixes.

Accordingly, the invention also provides a method for producing bakery products. The method comprises mixing the gluten substitute gum of the invention together with a gluten-free starch and water and optionally other ingredients to form a dough and heating the dough for a time and at a temperature sufficient to produce said bakery products.

Bakery products contemplated by the present invention include, but are not restricted to, flour, bread, buns, rolls, bagels, pizza base, pies, pastry, pancakes, muffins, crumpets, doughnuts, cakes, batter, biscuits, cake mixes, dumplings, and pasta.

The invention also encompasses any food products produced using the gluten substitute gum of the invention. In this connection, the subject gluten substitute gum has excellent thickening and binding properties. Accordingly, the gum can be advantageously used as a food additive, both for human and animal consumption. For example, when the gluten substitute gum is used as a thickener, it can compete effectively with modified starches, xanthan, guar and many other gums. Exemplary foodstuffs which can be prepared using the present gluten substitute gum include, for example, sauces, soups,

pastes, mayonnaise, dressings, snack foods, deserts, gravies, processed meats including sausages, salamis, hot dogs as well as canned and re-constituted pet foods.

In order that the invention may be readily understood and put into practical effect, particular preferred embodiments will now be described by way of the following non-limiting examples.

EXAMPLES

EXAMPLE 1

Preparation of a gluten substitute gum using tapioca starch and soybean flour

Ingredients	Gum #1	Gum #2	Gum #3	Gum #4	Gum #5
Tapioca starch	100 g	100 g	100 g	100 g	100 g
Soybean flour	25 g	37.5 g	20 g	10 g	5 g
Water	92 g	160 g	120 g	110 g	105 g

Each mixture of the above ingredients was blended into a wet paste, which was baked in a 750-Watt domestic microwave oven, on maximum setting at a rate of about 10 minutes per 2 x 100 g of paste. At 2 minutes this procedure yielded an aerated mass, which had expanded to about double the volume of the paste before baking. At 3 minutes the aerated mass had expanded to 3 times the volume of the paste before baking. Temperature analysis revealed that the aerated mass was formed in the range of from about 130-133 °C. At 10 minutes this procedure produced a dried solid mass. The dried mass was allowed to cool for several minutes before it was milled and crushed into a powdered gum. It should be noted, however, that excess baking produces charring. Thus, for a given heating/baking apparatus care should be taken to determine the optimal baking period per weight of paste. A person of skill in the art can determine these variables routinely in view of the present disclosure without undue experimentation.

A scaled-up preparation of Gum #5 was also carried out using a 6850-Watt microwave assisted heat pump drier. This preparation comprised baking 800 g of wet

paste for about 8-9 minutes at about 5000 Watts (power/weight of paste ratio of about 8-14:1). The dry gum thus produced had similar properties to Gum #5 produced with the domestic microwave.

EXAMPLE 2

Preparation of a gluten substitute gum by extrusion

Dry powder (95 wt% tapioca starch, 5 wt% soybean flour) was fed into an extruder at a rate of 80 kg/hour. Steam was added to the dry powder in the preconditioner at a rate of 9.5 to 10.5 kg/hour. The process was started wet, and water addition into the barrel of the extruder was steadily reduced to increase pressure and therefore temperature. Screw speed was also adjusted to keep motor amps (30 or 28 amps) (and therefore mechanical shear) as low as possible. A relatively high screw speed of (375 or 373 rpm) was used. The operating temperatures at which samples were collected are shown in the following table. No jacket heating was applied in Zone 5. Thus, Zone 5 temperature is a good indication of the maximum product temperature achieved.

Extrusion Parameter	Gum #6	Gum #7
Dry feed rate (kg/hour)	80	80
Steam addition to preconditioner (kg/hour)	10.3	9.5
Discharge temperature from preconditioner (°C)	45	48
Extruder screw speed (rpm)	375	373
Extruder motor amps	30	28
Water addition into barrel (kg/hour)	6.6	9.3
Temperature Zone 1 (°C)	43	47
Temperature Zone 2 (°C)	71	56
Temperature Zone 3 (°C)	78	60
Temperature Zone 4 (°C)	114	100
Temperature Zone 5 (°C)	149	144
Pressure at die (bar)	28	25

The product, which exited from the die, expanded significantly and was cut into balls before cooling and milling through a hammer mill.

EXAMPLE 3

Comparison of microwave oven produced (M) and extruder produced (E) gums

Property	*Gum M*	*Gum E*
Weight per liter	870 g	560 g
Water absorption per 100 g of gum to form a solid mass	92 g	50 g
Gum characteristics	Rapidly disperse water through dry gum	Does not disperse water through dry gum
	Forms a solid mass with strong cohesion	Forms a sticky liquid at point of contact with water. Water does not penetrate into dry gum.
	Adheres to itself instead of other materials	Initially adheres to other materials but becomes self-adherent with additional mixing.
	Has no perceptible odour	Has a fruit-like odour
	Requires almost equal amounts of water to gum to form a mass	Requires about half the amount of water to gum to form a mass
	Swells during absorption of water	Contracts during absorption of water
	Weight to volume ratio similar to gluten	Weight to volume ratio smaller than gluten (*i.e.*, it has larger, lighter bulk)
Dough characteristics	Requires approx. 160 g/kg of gum to starch to make a dough	Requires approx. 200 g/kg of gum to starch to make a dough
	Requires about 580 g water per kg flour to make a good dough (equivalent to wheat	Requires about 470 g water per kg flour to make a good dough (19% less than wheat flour)

Property	*Gum M*	*Gum E*
	flour)	
	Flour readily mixes with water to make a good dough	Flour forms a small central wet spot that must be mixed for several minutes to collect and incorporate loose flour
	Dough is mixed to similar consistency as wheat (moisture, feel, stretch and stickiness)	Dough is mixed to a consistency which is not similar to wheat (feels much drier, does not have similar stretch characteristics)
Bake characteristics	Has single rise (in about 20 minutes @ 50°C)	Has single rise (in about 30-40 minutes @ 50°C)
	Will not rise further when baking heat applied	Rises further when baking heat applied

EXAMPLE 4

Preparation of a gluten substitute gum using tapioca, edible fat and edible protein

Ingredients	Gum #8	Gum #9	Gum #10	Gum #11	Gum #12
Tapioca starch	50 g	50 g	50 g	50 g	50 g
Dried egg white	-	3 g	-	3 g	-
Olive oil	-	-	3 g	3 g	-
Whole milk powder (28wt% protein, 26wt% fat)	-	-	-	-	22 g
Water	50 g	50 g	50 g	50 g	50 g

Each mixture of the above ingredients was blended and subsequently baked for 10 minutes in a 750-Watt domestic microwave oven, on maximum setting. An aerated mass with similar properties to those of Example 1was obtained with Gums #11 and 12.

EXAMPLE 5

Bread produced with Gum #5 and Maize Starch

The flour mix used in this recipe is a blend of 500 parts maize starch to 60 parts soybean flour to 90 parts Gum #5.

Ingredients
580 g Flour
2 tablespoons (30 mL) dry yeast
2 teaspoons (10 mL) salt
1.5 tablespoons (22.5 mL) sugar
390 g water at 50 °C

Liberally grease a bread pan. Pre-heat an oven to 50 °C. Place all dry ingredients into a mixing bowl and mix. Add water (at 50 °C) and mix on low speed until combined. Keep mixing on medium speed until consistency is almost fluid. Turn out onto counter and lightly shape. Wait a minute or so before handling, as the dough cools it will form a light skin. Divide into 2 balls and place into bread pan. Place into pre-warmed oven and turn off the heat. Allow to rise for 20 minutes - If you allow it to rise longer, it will collapse more when full heat is applied. Turn heat up to 180 °C and bake for 40 minutes. When baked turn out immediately or steaming will occur.

EXAMPLE 6

Shortcrust Pies produced with Gum #5 and Maize Starch

The flour mix used in this recipe is a blend of 500 parts maize starch to 60 parts soybean flour to 90 parts Gum #5.

Ingredients
350 g flour

Ingredients
80 g melted butter
1 teaspoon (5 mL) baking powder
1/2 (0.5) teaspoon (2.5 mL) salt
80 g caster sugar
80-90 g water (hot)
1 egg (60-65 g)
A little egg white
400 g mashed pie apples

Pre-heat an oven to 180 °C. Liberally grease four pie tins. Dissolve sugar in 80 g of water. Place all dry ingredients into a mixing bowl and mix. Add sugar water, egg and melted butter and mix on low speed with K beater. Keep mixing until consistency is pliable but not too fluid. Add water if required to achieve desired consistency. Turn out onto lightly floured counter and roll out to desired thickness. If dough crumbles or is hard to roll, re-mix with a few more mL of water. (Dough can be re-combined and re rolled many times.) Cut out pie bases and tops, place into greased pie tins. Lightly brush inside of pie shell with egg white. Fill each pie shell with approx 100 g of mashed pie apples. Put tops onto pies and seal edges. Cut a slot into each top to allow for expansion of the filling during baking. Bake for 30 minutes at 180 °C.

EXAMPLE 7

Chocolate Cake produced with Gum #5 and Maize Flour

The flour mix used in this recipe is a blend of 500 parts maize starch to 60 parts soybean flour to 90 parts Gum #5.

Ingredients
150 g flour
200 g caster sugar
35 g cocoa
60 g butter
120 g skim milk
3 teaspoons baking powder
1 teaspoon vanillin sugar
2 small (45-50 g) eggs

Pre-heat an oven to 180 °C. Add 2 teaspoons of baking powder to the flour. Add cocoa to flour and sift - ensure there are no lumps in the cocoa. Blend sugar, butter and 1 teaspoon vanillin sugar. When butter and sugar are blended add eggs and beat till creamy. Mix in at low speed about 1/3 of the flour/cocoa and about 1/3 of the skim milk. Repeat until all the ingredients are combined - do not over beat. Pour into pan in layers and bake at 180 °C for 35 minutes

Throughout the specification the aim has been to describe the preferred embodiments of the invention without limiting the invention to any one embodiment or specific collection of features. Those of skill in the art will therefore appreciate that, in light of the instant disclosure, various modifications and changes can be made in the particular embodiments exemplified without departing from the scope of the present invention. All such modifications and changes are intended to be included within the scope of the appendant claims.